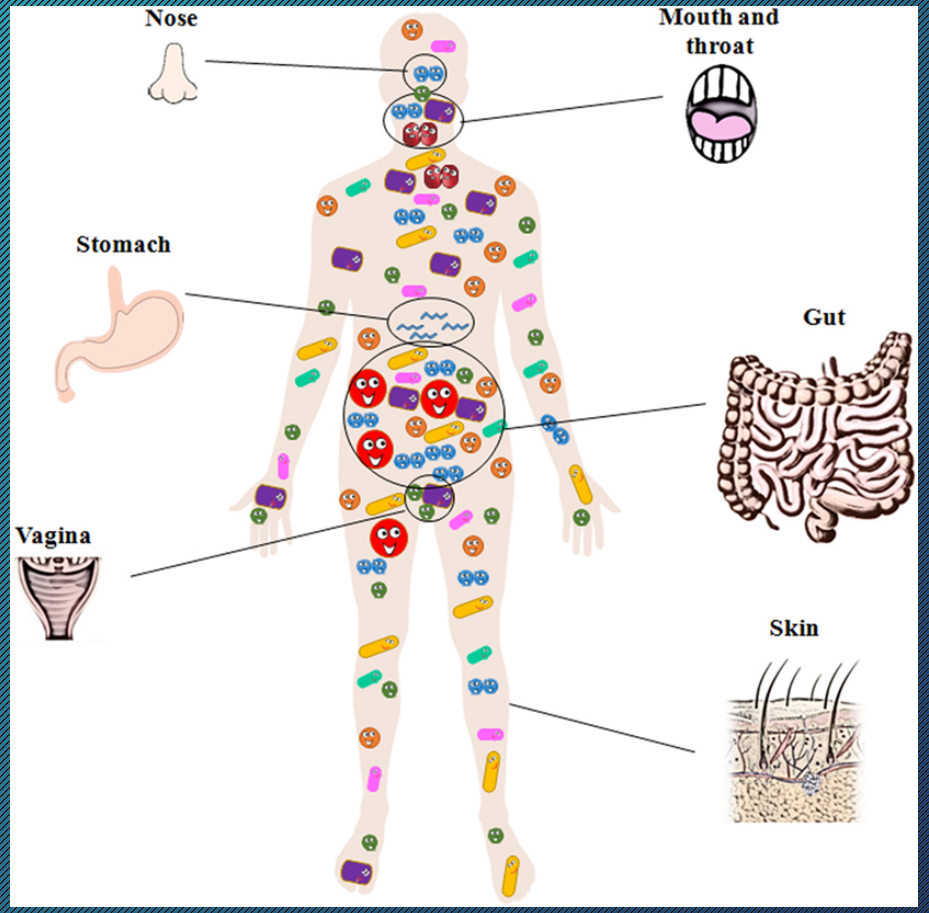
Microbial Flora

Dr. Basma Samir (MD)

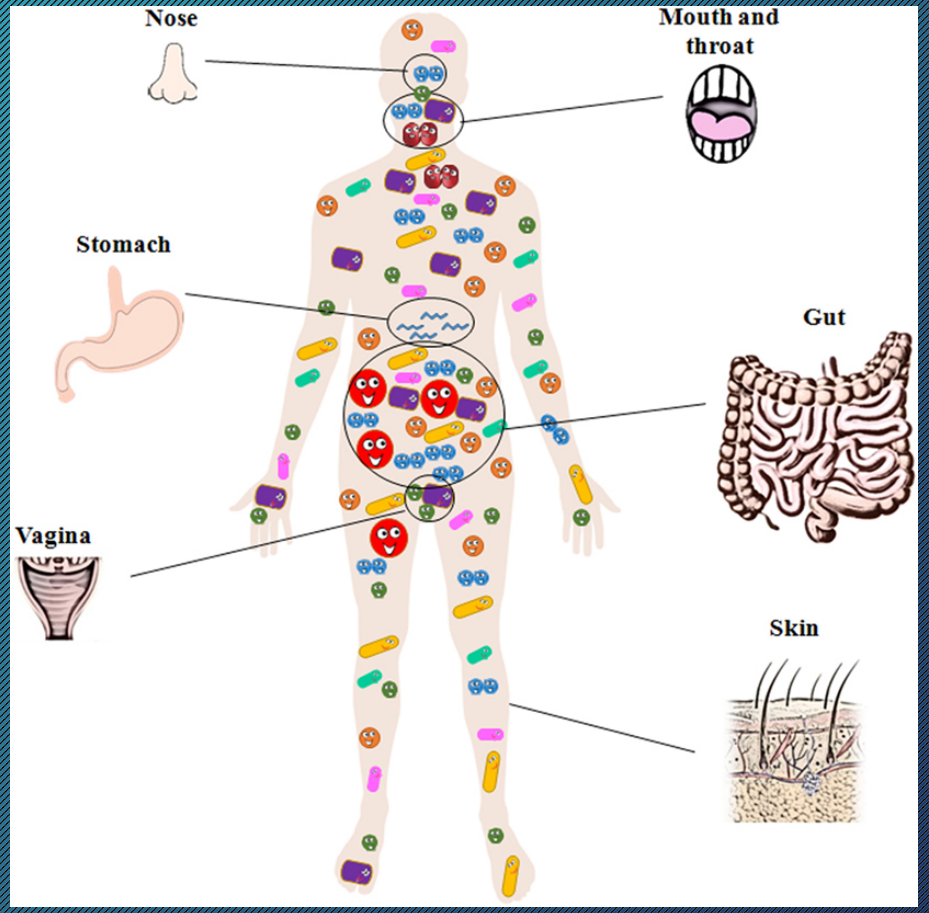
Microbes and Us

- The human body, routinely harbors about 10^{14} bacteria.
- We are covered in microorganisms !
- Microbes that colonize the human body during birth or shortly thereafter, remaining throughout life, are referred to as **Normal Flora**.



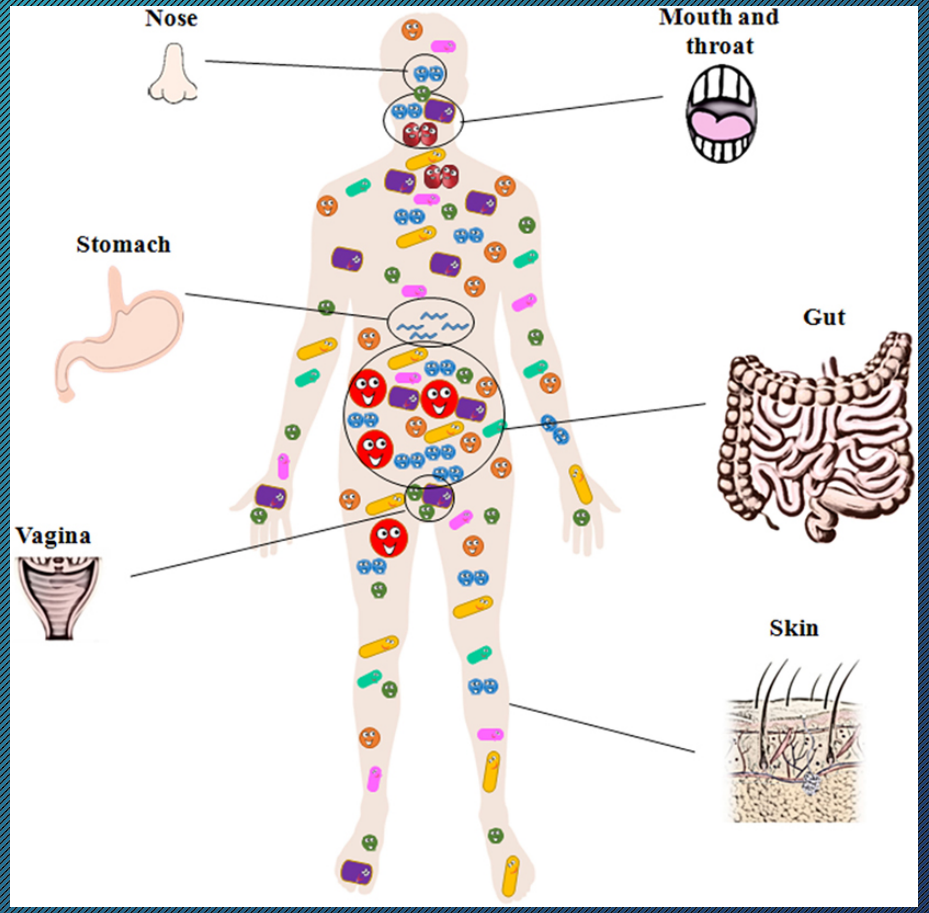
Microbes and Us

- This bacterial population constitutes the normal microbial flora that has the tremendous ability to replenish itself if temporarily disturbed.
  - (For example, by washing the skin or using antibiotics).



Microbes and Us

- Normal flora can be found in many sites of the human body.
- Areas of the body such as the brain, the circulatory system and the lungs are intended to remain sterile (microbe free).



Resident Flora

Resident Flora

- Healthy people live in harmony with most of the microorganisms that establish themselves on or in (colonize) non-sterile parts of the body, such as the skin, nose, mouth, throat and large intestine.
- **Microorganism populations that usually occupy a particular body site are called the Resident Flora**.

Resident Flora

- Resident flora often protects the body against disease-causing organisms.
- However, under certain conditions, microorganisms that are part of a person's resident flora may cause disease.

Resident Flora

- The main factor determining the composition of normal flora in a body region **is the nature of the local environment**, **which is determined by**:
  - pH, temperature, oxygen, water, and nutrition
  - Antibiotic use, sanitary conditions, air pollution, and hygienic habits.
- Other factors such as peristalsis, saliva, lysozyme secretion, and secretion of immunoglobulins also play roles in flora control.

Example:

- A Gram-positive population predominates in the gastrointestinal tract early in life if the infant is breast-fed.
- This bacterial population is reduced and displaced somewhat by a Gram-negative flora when the baby is bottle-fed.

Significance of Microbial Flora

Microorganisms of the normal flora

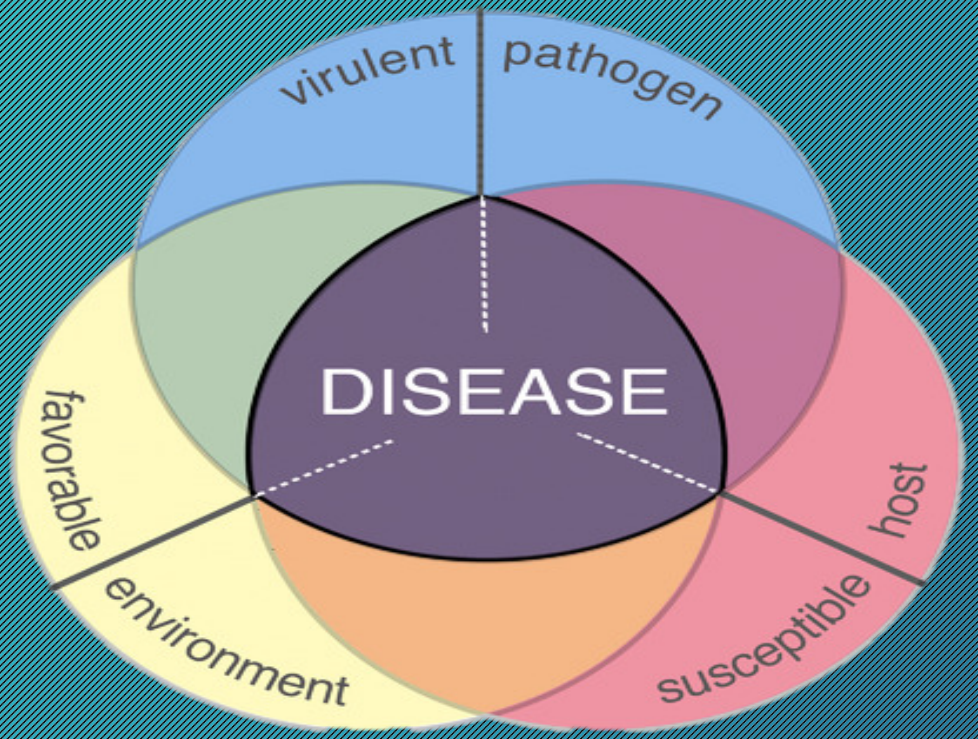
- **may aid** the host by:
  - competing for microenvironments more effectively than pathogens
  - producing nutrients the host can use,
  - providing a first line of **defense** against microbial pathogens,
  - assisting in digestion by breaking down food in the intestine,
  - playing a role in toxin degradation, and
  - contributing to maturation of the immune system.

Significance of Microbial Flora

Microorganisms of the normal flora

- **may harm** the host (by causing dental caries, abscesses, or other infectious diseases).
- **may exist as commensals** (inhabiting the host for long periods without causing detectable harm or benefit).

Shifts in the normal microbiota or stimulation of inflammation by these commensals may cause diseases.



Host-Microbe Relationship

The human body provides environments for microbial flora to live.

In this context, the human body is the Host.

A positive host-microbe relationship is usually described as mutual or commensal relationship:

- Mutual benefit for both the host and the microbe.
- Commensals, where the microbe benefits and the the host is neither benefited nor harmed.

Host-microbe relationship depends on many factors:

- The host provides a niche and nutrition for the microbe and
- microbial communities may even aid in digestion or synthesize nutrients for the host.

Sometimes, Host-Microbe relationship can be described as **pathogenic**.

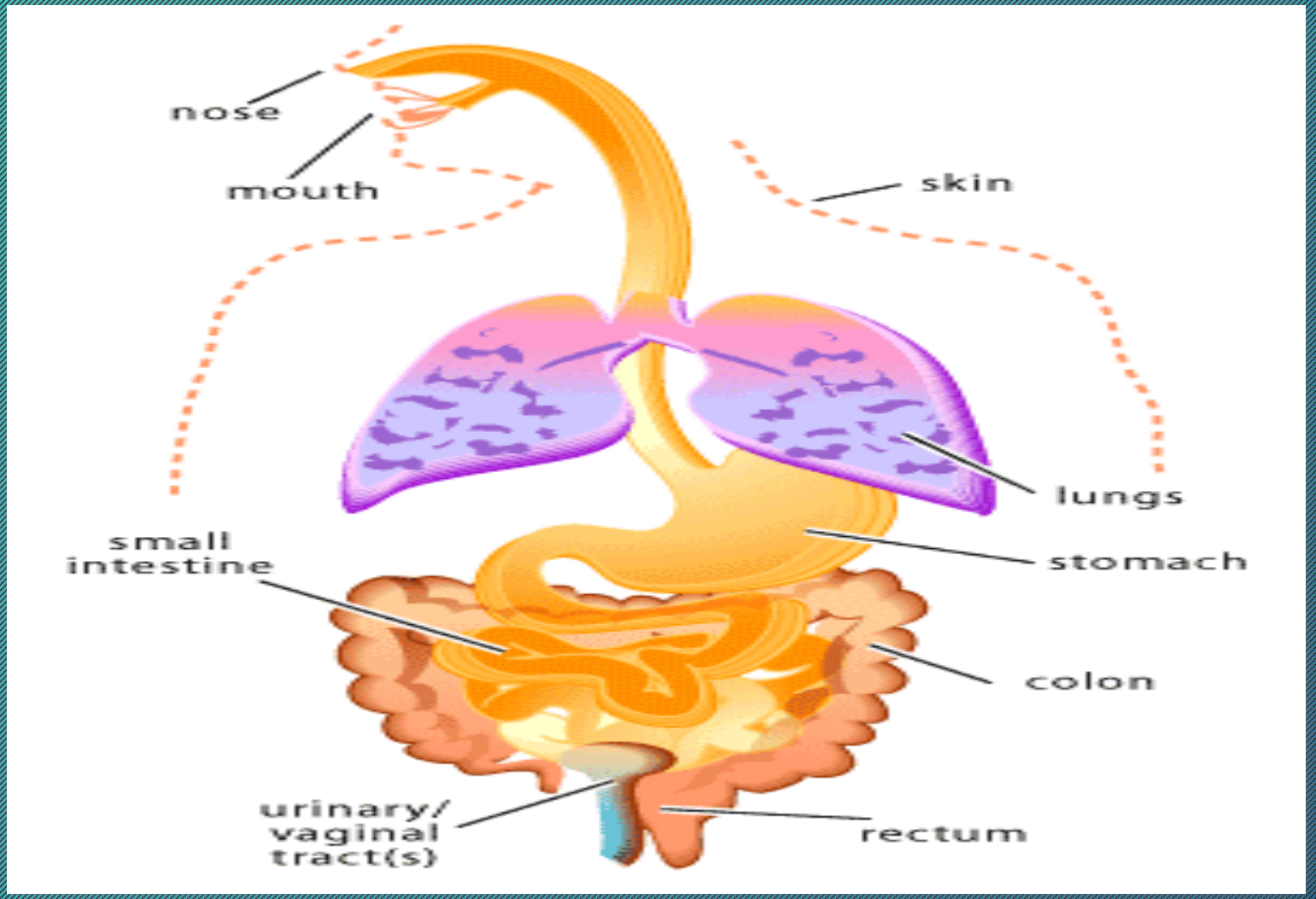
In such situation, the cost to the host can vary from slight to fatal.

How Microbial Flora can cause harm??

- **Excessive use of antibiotics** to treat an infection
  - kills a large proportion of certain types of bacteria of the resident flora, other resident bacteria or fungi can grow unchecked.
- **Injury** can allow resident flora to enter areas that are not supposed to have bacteria and cause infection.
  - For example, a cut on the skin can allow resident skin flora to cause an infection under the skin.

How Microbial Flora can cause harm??

- **Surgery** on the large intestine sometimes allows the resident flora in the intestine to spill into sterile areas in the abdomen and cause very serious infection.
- **A weakened immune system** (as occurs in people with AIDS or cancer, people taking corticosteroids, and those receiving cancer chemotherapy).



Location of normal microbial flora

Each of these areas of the body contain their own microenvironments and various inhabitants of microbes

Skin Microbial Flora

Human skin is not a particularly rich place for microbes to live.

- The skin surface is relatively dry,
- slightly acidic and
- the primary source of nutrition is dead cells.

Staphylococcus aureus

- S. aureus is extremely common on the skin of patients with certain dermatologic diseases.

Micrococci

- Micrococci are frequently present on normal skin.

Staphylococcus epidermidis

- A major inhabitant of the skin, and in some areas it makes up more than 90 percent of the resident aerobic flora.
- Gram positive bacterium can survive at many sites throughout the body.
- S. epidermidis can cause life threatening disease in hospital patients when invasive medical devices such as catheters are used.

Staphylococcus epidermidis

- In such cases, *S.* epidermidis form antibiotic resistant biofilms along the catheter and enter the bloodstream causing systemic infection that can be fatal.
- Under this scenario, *S.* epidermidis would be considered an opportunistic pathogen, since it remains benign until provided with specific conditions that allow it to cause disease.

Corynebacterium Diphtheroids (Coryneforms)

- Anaerobic diphtheroids are most common in areas rich in sebaceous glands.
- Skin anaerobic diphtheroids, found in acne lesions and is probably involved in acne pathogenesis.

Streptococci

- α-hemolytic streptococci, exist primarily in the mouth, from where they may, in rare instances, spread to the skin.

- β-hemolytic streptococci, are rarely seen on normal skin due to the presence of lipids on the skin, as these lipids are lethal to streptococci.

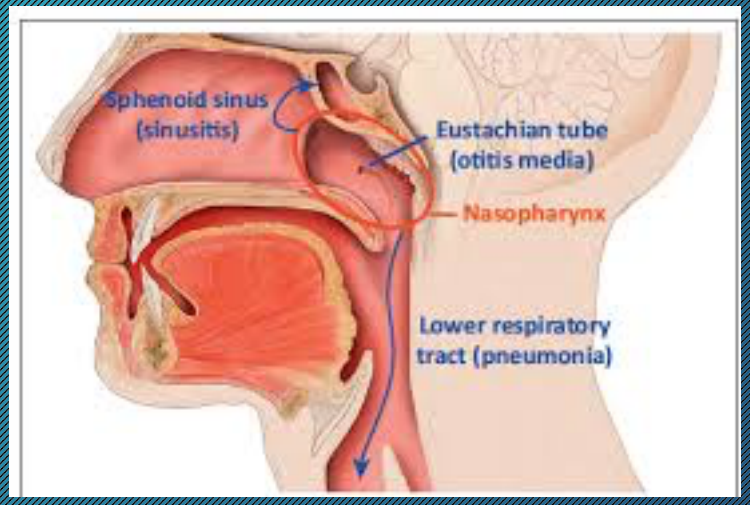
Gram-Negative Bacilli

- They make up a small proportion of the skin flora.
- They are seen in moist areas, such as the toe webs, **and not on dry skin**.
- Desiccation (Dryness) is the major factor preventing the multiplication of Gram-negative bacteria on intact skin.
- Enterobacter, Klebsiella, Escherichia coli, Acinetobacter spp and Proteus spp. are the predominant Gram-negative organisms.

Nail Flora

- The microbiology of a normal nail is generally similar to that of the skin.
- Dust particles and other materials may get trapped under the nail, depending on what the nail contacts.
- In addition to resident skin flora, these dust particles may carry fungi and bacilli. Aspergillus, Penicillium are the major types of fungi found under the nails.

Nose Microbial Flora

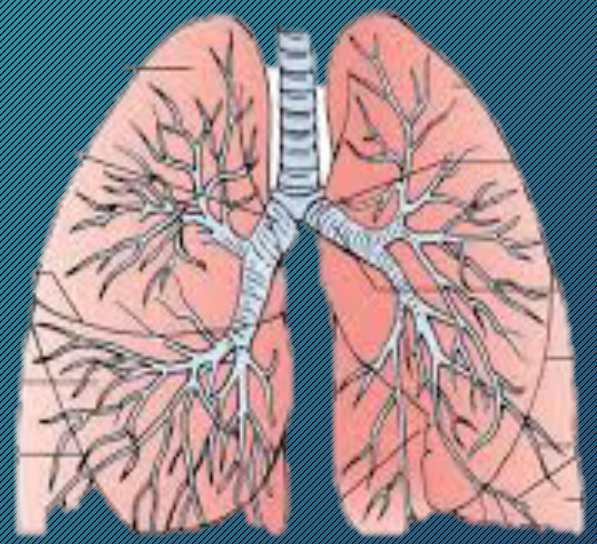


Nose

The human nose is home to the:

- Gram positive Staphylococcus aureus,
  - a major cause of surgical wound and systemic infection.
- **MRSA**, **M**ethicillin **R**esistant **S**taphylococcus **a**ureus.
  - Infections of this bacterium are now a very serious threat to human health because it has become resistant to all commercially available antibiotics, including methicillin and vancomycin.

Respiratory Tract Flora



Upper Respiratory Tract Flora

- The pharynx and trachea contain primarily bacterial flora found in normal oral cavity. Anaerobic organisms also are reported frequently.
- Staphylococci, Neisseria meningitides, C. diphtheriae , Bordetella pertussis, and others are also present.
- Upper Respiratory tract flora could be considered the first region of attack for such organisms.
- Potentially pathogenic organisms such as Haemophilus, Mycoplasmas, and Pneumococci may also be found in the pharynx.

Lower Respiratory Tract Flora

The lower respiratory tract (small bronchi and alveoli) is usually sterile, because

- Particles the size of bacteria do not readily reach it.
- If bacteria reach these regions, they encounter host defense mechanisms, such as alveolar macrophages, that are not present in the pharynx.

Oral Cavity

Oral Flora

- It is estimated that 500-600 different kinds of bacteria thrive on mucus and food remnants in the mouth.
- It is involved in dental caries and periodontal disease.
- Anaerobes in the oral flora are responsible for many of the brain, face, and lung infections that are frequently manifested by abscess formation.

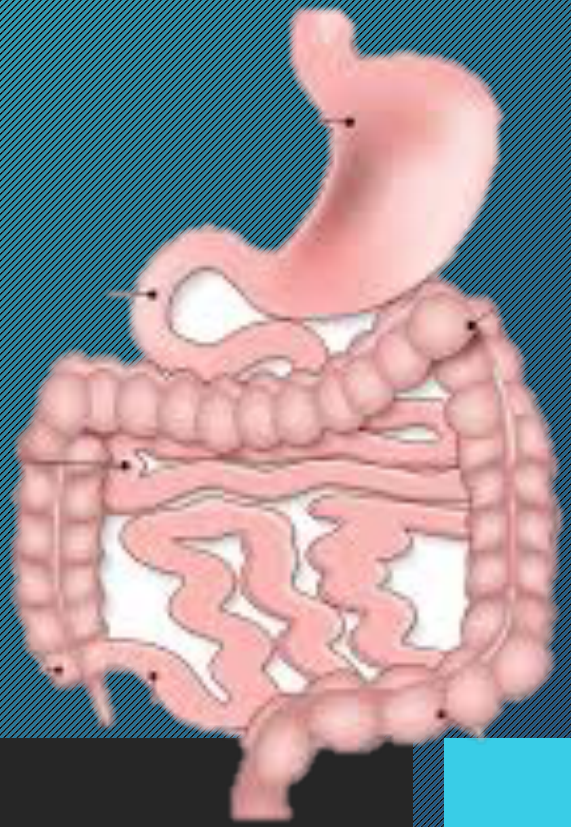
Streptococcus mutans

- A predominant member of this community.
- It grows on biofilms on the surface of teeth (plaque) where it consumes sugar and converts it to lactic acid.
- Lactic acid erodes the enamel on the surface of teeth, which leads to the formation of cavities.

Streptococcus pneumoniae

- A much more threatening bacteria that can colonize the mouth.
- An opportunistic pathogen that resides in the mouth and throat awaiting an opportunity to infect the lungs when defense systems are low, such as following an infection with influenza (the flu).

Gastrointestinal Tract Flora



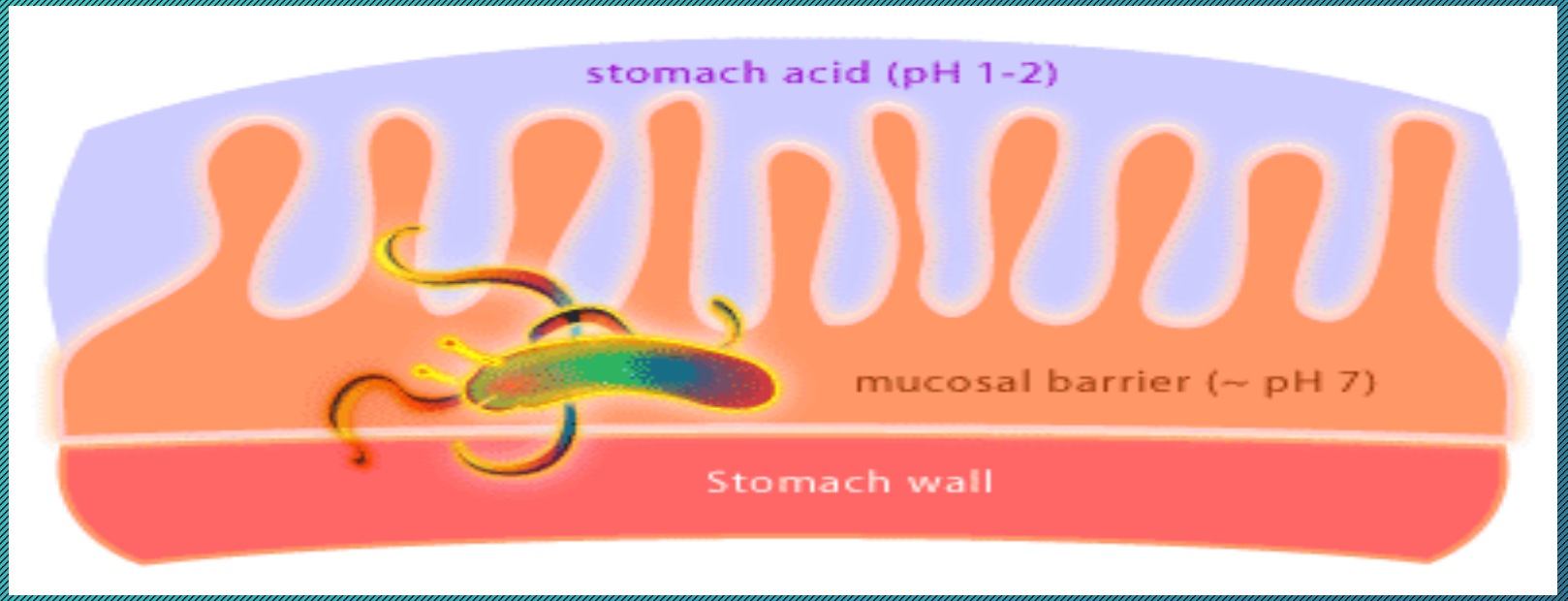
Stomach

- It contains bacteria swallowed with the food and those dislodged from the mouth.
- The stomach is a relatively hostile environment for bacteria due to low pH.

Braving Stomach Acid

- Organisms in the stomach are usually transient, and their populations are kept low by acidity.
- What kind of organism would live in a highly acidic (pH 1-2) environment like the stomach?

- Approximately 30-50% of humans are colonized by H. pylori.
- Remarkably, gastric ulcers develop in less than 20%.



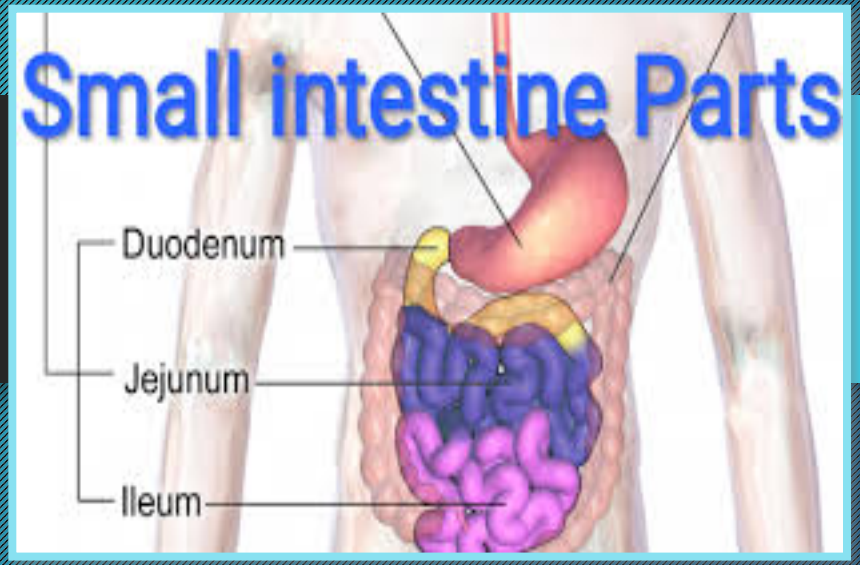
H. plyori survival in low stomach pH

- Creates it own microenvironment by burrowing into the mucosal lining of the stomach.

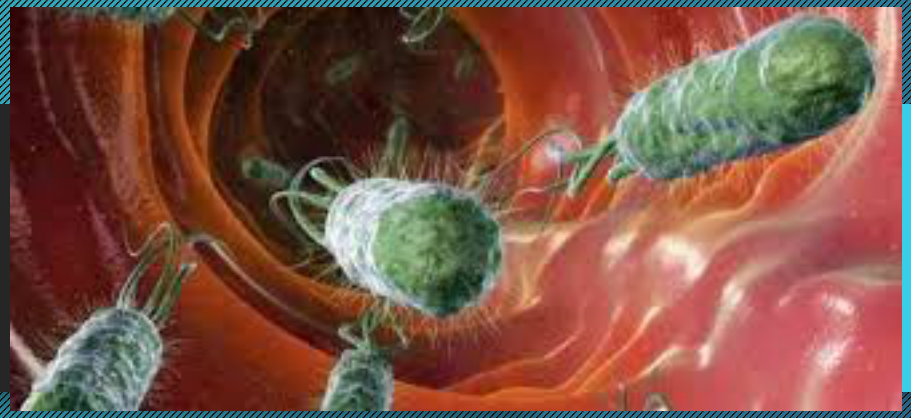
Within the lining, the microbe is able to avoid pH levels that would normally kill it. Here, it may also produce ulcers.

- In addition, H. pylori produces an enzyme called urease to convert urea produced by the stomach into ammonia and carbon dioxide.

Duodenum & Ileum

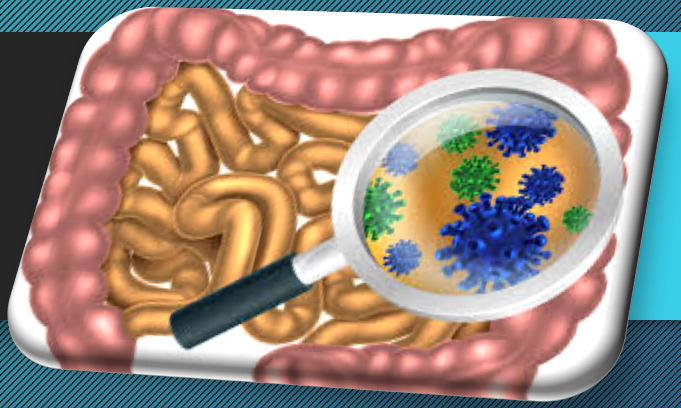


- In normal hosts the duodenal flora is sparse (little microbial flora).
- The ileum contains a moderately mixed flora.
- Rapid peristalsis and the presence of bile may explain in part the paucity of organisms in the upper gastrointestinal tract.



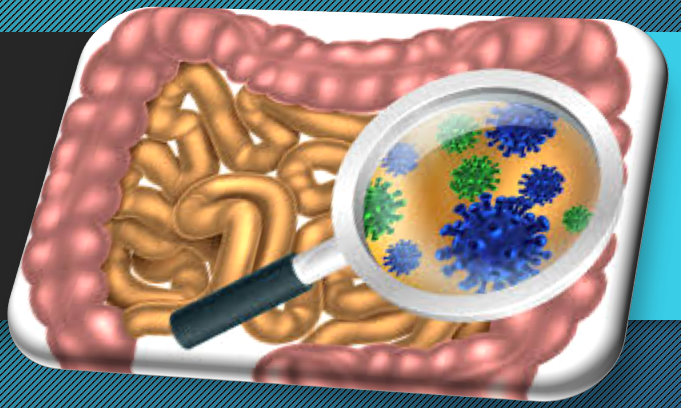
- Further along the jejunum and into the ileum, bacterial populations begin to increase, with streptococci, lactobacilli, Bacteroides, Clostridium and bifidobacteria predominating.

Large Intestine



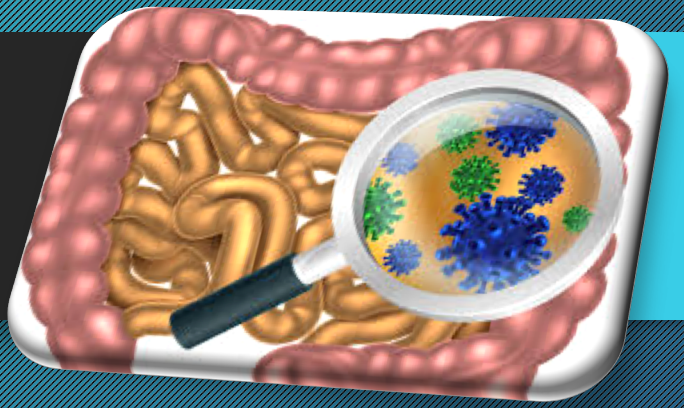
- Higher concentrations are frequently found in human colon and feces.
- This flora includes a big array of bacteria (more than 400 species have been identified); 95 to 99 % belong to anaerobic genera.
- These organisms participate in
  - bile acid conversion and
  - in vitamin K and ammonia production in the large bowel.

Large Intestine



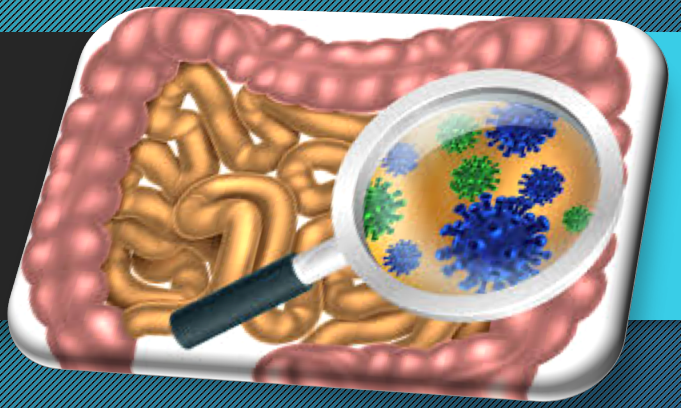
- Anaerobic bacteria proliferate, occupy most available spaces, and produce metabolic waste products such as acetic, butyric, and lactic acids.
- The strict anaerobic conditions and bacterial waste products are factors that inhibit the growth of other bacteria in the large intestine.
- Anaerobes in the intestinal tract are the primary agents of intra-abdominal abscesses and peritonitis.

Large Intestine



- Bacteria packed into the lumen account for about 35-50% of the colon contents.
- The colon is a holding tank for bacteria that participate in the end stages of food digestion.
  - For it is here that bacteria are presented with polysaccharides that cannot be broken down by human enzymes.

Large Intestine



- These polysaccharides are derived from plant material (eg. cellulose and pectin) and from human cells (eg. the polysaccharides that glue intestinal cells together) and are readily degraded by colonic bacteria.
- Polysaccharide degradation results in the production of acetate, butyrate and propionate, which are used as a source of carbon and energy by mucosal cells of the colon.

Stomach vs. Small Intestine

- Compared to the stomach, the small intestine is a relatively hospitable environment.
- Peristalsis (small intestine movements) makes it difficult for bacteria to colonize the small intestine because they get washed out very quickly.
- As a result, the concentration of bacteria in the small intestine remains relatively low and human enzymes carry out most of the digestion processes.

Small Intestine vs. Large Intestine

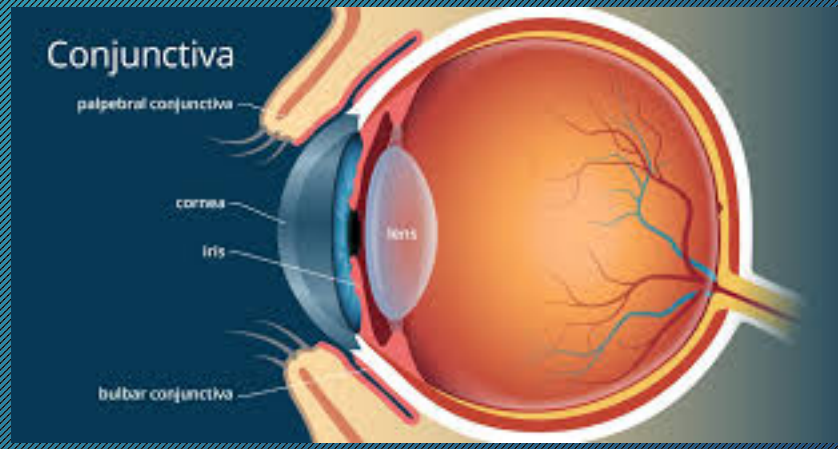
- In the colon, things slow down.
- While it takes about 3-5 hours for food to move through the small intestine, it takes 24-48 hours for food to travel through the colon.
- This slower flow rate gives enough time to bacteria in the colon to reproduce so that they reach very high concentrations.

Urogenital Flora

Urogenital Flora

- In the anterior urethra of humans, *S. epidermidis*, enterococci, and diphtheroids are found frequently;
- E. coli, Proteus, and Neisseria (nonpathogenic species) are reported occasionally.

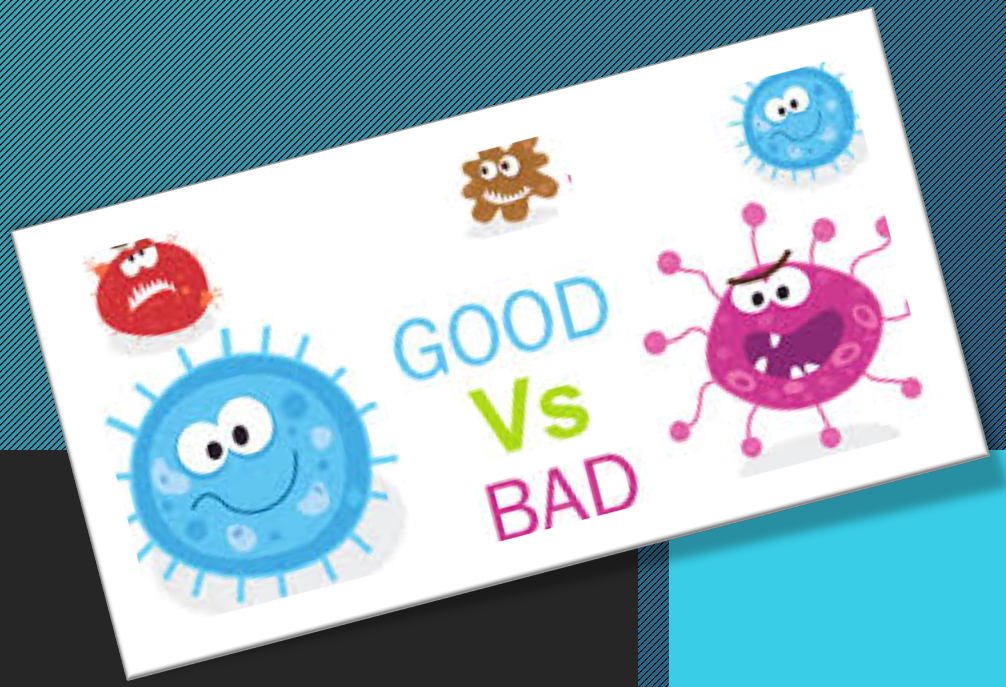
Conjunctival Flora



Conjunctival Flora

- The conjunctival flora is sparse (Little microbial counts).
- Lysozyme, secreted in tears, may play a role in controlling bacteria by interfering with their cell wall formation.
- Haemophilus, Streptococci and Staphylococcus are among the genera most often detected.

Host Infection



Opportunistic Infection

- Many elements of the normal flora may act as opportunistic pathogens, especially in hosts rendered susceptible by rheumatic heart disease, immunosuppression, radiation therapy, chemotherapy, perforated mucous membranes, etc.

Bringing it All Together

The previous examples describe a few microorganisms of normal flora around the human body.

From these examples several common themes can be extracted and to summarize, let's discuss these themes:

1. Bacteria perform physiological, nutritional and protective functions in the human body.
2. Maintaining a balance is crucial.

- Normal flora consists of communities of bacteria among other microorganisms that function as microbial ecosystems.
- If these ecosystems are disrupted the consequences can be unpredictable.
- Antibiotics, tissue damage, medical procedures, changes in diet, and the introduction of new pathogens are examples of changes that can affect your normal flora.

Discussed Topics

- Normal Microbial Flora
- Significance of Microbial Flora
- Host-Microbial Relationship
- Sites of Resident Microbial Flora
- Host Infection

- Skin & Nails
- Nose
- Upper Respiratory Tract
- Oral cavity
- Stomach
- Intestine
- Urogenital
- Conjunctiva

Thank You